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The Development of Web-Based SCM Game Systems for MBA Students

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Abstract

Today's advanced web application technology leads to the development of web-based teaching materials that can be used in varied ways in MBA level classes. The purpose of this study is to discover the feasibility of several effective web-based game-type systems for teaching Supply Chain Management (SCM) to MBA students. Three types of web systems have been defined; and Type 3, which can be realized by using web pages with embedded programs, has been clarified to be the most effective method to deliver the SCM game systems. Accordingly, three web-based game systems have been developed for this purpose. The three systems are the following: "a simulation of one-card kanban system", "demand forecasting" and "the beer game". These three systems have been piloted in the MBA classes of Josai University, and the results of the study show that they are effective in the MBA education program.

Key Words: web-based system, SCM, one-card kanban system, demand forecasting, the beer game, MBA program

Purpose of the Study

The MBA program at Josai University teaches the recently developed Supply Chain Management (SCM) theory to the students. Some concepts and effects of SCM are not easily taught using written textbooks and ordinary verbal lectures. The purpose of this study is to determine the effectiveness of some web-based game-type systems as SCM teaching aids for the MBA students.

Three Types of WEB Systems

Web Applications

Web applications are web sites that provide functions beyond those offered by static web pages. The most important advantage is that downloading and installing user interface software on the user's PC is not necessary. Web applications can be run on any system that supports a browser. It also allows users to access the information from inside the university or from home without needing special configurations. Moreover, web applications allow for the instant distribution of updates and revisions from a server.

Despite the above advantages, web applications have some disadvantages. First of all, browser based clients are more static and "flat" than ordinary program running directly on user machines. Since the browser is a better version of the conventional terminal and all interaction requiring user input is forms based, the interaction between the user and the client has to be a lower level.

Considering the above advantages and disadvantages, web applications have been selected as the teaching materials of the MBA program. Although there may be various methods of classification for web systems, a classification by user interaction's level is appropriate for the purpose of this study. The three types are defined below（Fukushima, 2004）.

Web System Type 1－Remote URL

Type 1 is a system that only sends information to users, which in this case means students. The students get their requested web contents remotely by providing a URL. The majority of the Internet traffic is currently of this type. While the word "remote" is used here, it does not necessarily mean the student is located far from the university; rather, it means that the student operates his or her own PC but not the server itself. The student may be in a classroom together with the teacher and other students, or he or she may be in a different place.

Web System Type 2－E-mail and CGI

This second type allows the students to feed information back through e-mail facilities like an e-mail server or other Common Gateway Interface（CGI）web programs. The student remotely provides information by completing a form on the web, and in most cases the student is asked to give an ID code. Finally, the student clicks a "submit" button to finish the procedure. After some time, an e-mail acknowledging the receipt of the information and containing other necessary information is sent out.

Web System Type 3－Embedded Programs

The third type of web system can immediately process the information received, though the response may be delayed depending upon the complexity of the requests, the web server's performance, and the number of concurrent users. A Type 3 system can be realized in two ways: 1）as programs which output web pages, 2）or as web pages with embedded programs. The latter one is more popular now because of its convenience.

A web page with embedded programs does more than transfer the information; it is also interactive. Interactive web programs, some of which are coded inside the web pages, are executed by the web server. All these programs even as the embedded programs with the web pages are invisible to the students.

Three WEB-Based Teaching Systems

The following three web-based systems were developed as MBA teaching materials. These are "a simulation of one-card kanban system," "demand forecasting" and "the beer game". All three of these applications were provided as Type 3 web systems. The reasons why Type 3 was selected are explained in each case as follows.

A Simulation of One-Card Kanban System

Since the word "kanban" is Japanese for card, "one-card kanban" seems to be a redundant expression. Precisely, the simulation should be thought of as a kanban system that is operated by one card (Hopp and Spearman, 1996). The cards are used to direct the production of a designated item and volume within a predetermined lead time. The most important thing is that the production request does not come from any production plan, but comes directly from the customer. The kanban system invented by the Toyota Motor Corporation has greatly impacted not only the auto industry but also a wide range of businesses. The concept of Just-In-Time has also been applied to other businesses such as convenience stores, where all the items are stocked in small volumes and are replenished in small amounts whenever a given item is sold.

The Toyota kanban system is categorized as a pull system. The definition of a pull system by American Production and Inventory Control Society is a system in which items are produced only when demanded for use or when needed to replace those taken for use (APICS, 1995). The kanban is used as a production request from the customer or from a later process, which is considered to be the same as a customer for the current process.

Despite the importance of teaching the kanban system in the MBA program, it is not so easy to explain the essentials of the system to students. In particular, explaining how the WIP (Work-In-Process) can be maintained at low level by the kanban system is especially difficult, even if customer demand varies in a limited range. It is time consuming for students to fully understand the system if the instructor only uses a static text. By adopting a web-based system for teaching the kanban, the student can request any demand volume and can see how the WIP level varies according to the demand change. In the case that the demand fluctuation is within a predetermined range, the students can see that the WIP is maintained the lowest level. These dynamic changes of the volume figures are shown on a web page. This helps the students understand the kanban system. While this web-based system may not actually be a game, it functions like a game system because any demand volume can be inputted by the students and the WIP results are then displayed on a web page, just like a game.

When a student inputs a customer's demand request into the last process in the supply chain, the pulled data immediately goes back to the previous processes and the WIP and inventory volumes are calculated. These figures are shown on the program web page. The ease of interaction in this procedure is the main reason why a Type 3 web system was applied to this simulation of a one-card kanban system. The other important reason for using a Type 3 web system is that the system is copy-protected.

Demand Forecasting

This system can also be categorized as a Type 3 web system. In this simulation, the most appropriate demand forecasting method is chosen according to the demand characteristics. Actual past demand data are given to the students, and they have to find the best statistical method for forecasting the future demand using the past data. The students send their indi-

vidually forecasted data to the server by way of a web page. A program on the server receives the data and calculates the deviation and the dispersion of forecast errors for all the students' forecasts. A list of student forecasts beginning with the student with the lowest forecast error is generated. This functions as a competition through which students can compete with each other to attain the most accurate forecasting results.

The forecasted data is sent to the server in an Excel file for several reasons. A student needs to use a spreadsheet to develop better forecasting methods because he or she has to calculate the deviation and the dispersion figures of the forecasting error in the process. Moreover, the program on the server easily recognizes the student's resulting forecasted figures in spreadsheet form. Each time a student submits data, the program calculates the forecasting error immediately and updates the list that shows the results of the student competition. However, that list is not available until the teacher releases it.

The game starts with a detailed explanation about the game for the students. The teacher asks the students to do this assignment as homework and gives them a deadline for submission. After the deadline, the list is released to the students, and then each student can know how accurate his or her own forecasting method is compared with those of the other students. Although there is no universally approved method for demand forecasting, the students will be highly motivated to find an effective approach by competing with each other.

The Beer Game

The beer game has become one of the more popular business games in the operations management course of MBA programs（Meredith and Shafer, 2002）. Doing a simulation of the beer game is actually more difficult than merely studying about it in textbooks. This was the motivating force behind developing a web-based beer game that can be used in the MBA classes. Moreover, this game lends itself to being deployed using dynamic web pages rather than static pages.

The game simulates material and information flow in a simplified supply chain. A supply chain consists of a producer, a wholesaler, a distributor, a retailer and a customer, although the real beer industry may have multiple factories, a number of distributors, and many retailers. The game starts when the customer makes an order to the retailer for a certain quantity of beer. The order goes back from the retailer to the distributor, and then onward to the wholesaler, and finally from the wholesaler to the producer. Each supplier has its own inventory and has to manage its level appropriately. The object of playing the game is to minimize the total cost, which consists of the inventory cost and the backlog cost.

Keeping inventory incurs a cost; however, if the inventory level is too small, the item may be out-of-stock and a backlog cost is incurred. The backlog is the delayed quantity of the goods to be delivered to the customer or to the next supplier. The inventory cost is calculated at a predetermined rate for each unit of goods at the end of each period, while the backlog cost is also calculated in the same way but at another predetermined rate.

In playing the game, a student is assigned to one of the four supplying processes in the supply chain. Since the teacher can play the role of the customer, at least four students have to participate in each supply chain of the game. Moreover, if the game has only one supply chain, it cannot be called as a game system. It must have two or more supply chains, with each supply chain operated by a team of at least four students. The number of teams or supply chains is almost limitless. Not only is the cost of each of the supplying processes calculated, but the total cost of each supply chain（that is, each team）is also determined by the program on the server. In this way, all of the teams joining the game can compete with each other in order to attain the lowest total cost of the supply chain operations.

The purpose of the beer game was originally to help MBA students understand the meaning of the Bull Whip Effect in the field of SCM. The Bull Whip Effect is exhibited when a small change in one side becomes a bigger and bigger change to the opposite side, much like the movement of bull whip. Even if a change in demand from the customer is small, the effect is amplified in the upstream processes: retailer, distributor, wholesaler, and finally producer. The Type 3 web system developed for this study helps the MBA students comprehend the Bull Whip Effect by involving them in the beer game.

Technical Details for Each Web-Based Teaching Systems

The three web programs previously discussed have been coded using PHP language running with PHP Interpreter. These programs can be embedded within HTML files, or they can output the file directly in HTML format. After all the software needed to use the web server is installed in the PC, the web programs and other HTML and graphic files are then copied in the designated folders. Once the web server software is started, it is ready to serve the student users, who can access it using its IP address.

The following software, which can be downloaded free of charge, is required for the web server: Apache Web Server, MySQL, PHP Interpreter, and FTP Server.

Steps for Running the Simulation of One-Card Kanban System

1） Enter the demand amount and click the “Confirm” button to submit the value to the web system. The production, transfer and final inventory quantities at each workstation will be calculated and shown in this window.
2） Click the “Step1”, “Step 2”, “Step 3” and “Producing” hyperlinks to see the WIP changes at each workstation.
3） The results of each trial will be stored and shown in the window. Click “Restart” to erase all these results.

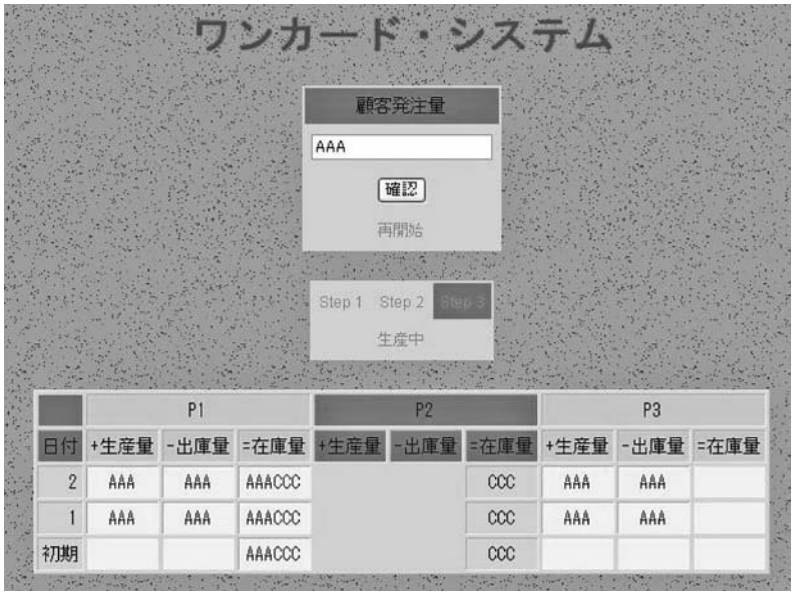

Figure 1　Operation Window for the One Card System

Demand Forecasting

1） Student Results File Submission Window: This screen is used for submitting the student-generated Excel file of the demand forecasting data. In the file, the student should include an explanation about how these resulting figures were calculated.

Figure 2 Student Results File Submission Window

2） Whole Class Student Results: All the results submitted will be shown here in ascending order based on the amount of forecasting error or variance. By clicking the designated hyperlink, an Excel file of the list can be opened or downloaded.

Figure 3 Whole Class Student Results Window

3） Settings Window: The Super User（SU）, normally the classroom teacher, sets the actual demand figures used for calculating the error in the student forecasts. When the “Announce” box is checked, the Excel file of all the student results is created. This file can then be made available to all the students, or it can be restricted for access by the SU only.

Figure 4 Settings Window

The Beer Game

1） Administration Window: This window is used for setting the parameters for the beer game, namely the initial inventory and cost, and for viewing the windows of the members of each group in order to check their current statuses.

Figure 5　Administration Window

2） Game Progress Window: This screen is used to monitor the game progress. The SU can know the progress of the beer game for each student in every group. With it, the SU can ask a particular student to increase his or her speed if he or she is taking too much time to select the order volume. The SU can also restart this game by clicking the appropriate hyperlink.

Figure 6　Window for viewing the game progress

3） Beer Game Operation Window: Each student who participates in the beer game can access the beer game functions by clicking on the pull-down menu. After entering the name and role for each student on the team and designating a password for each student,

the operation window for the beer game will appear. The beer game participants need to input the order quantities after evaluating the information provided to them.

Figure 7 Customer Operation Window

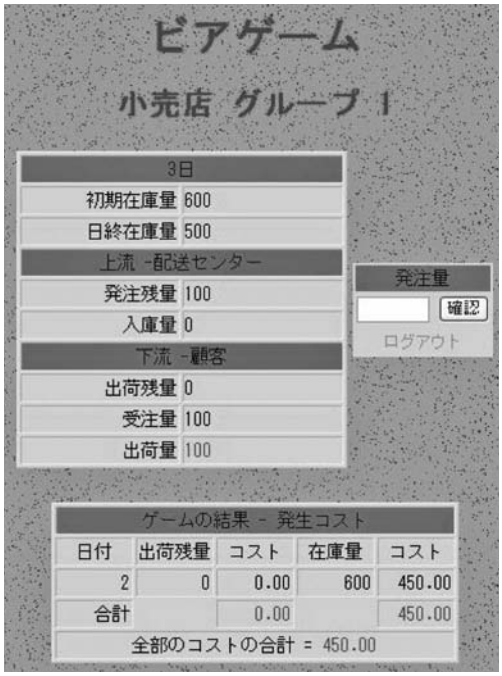

Figure 8 Retailer Operation Window

Conclusions

The three web-based game-type teaching systems have already been piloted in the MBA classes of Josai University, and the results of the study showed that they were effective in the MBA education program. A survey was made of the MBA students involved in the pilot program, questioning them about the value of the three web-based systems in relation to their study of SCM. The outcome of the survey indicates that many students think it was helpful to study the kanban system, demand forecasting, and the bull-whip effect using the programs and that using the web-based systems to minimize the total supply chain cost was much easier to understand than studying the concept using textbooks. The three teaching systems are

slated to be used successively in the coming school year at the MBA program. The effectiveness of these teaching materials in the MBA program will further be studied and reported upon in future articles.

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